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Militarising the Mind: Assessing the Weapons of the Ultimate Battlefield

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Abstract: *Advancements in behavioural neuroscience have revolutionised the treatment of mental illness by elucidating the mechanisms underpinning human behaviour and cognition. These advancements are not completely benevolent, but have dual-use potential which harkens back to a darker time when states sought to influence and control each other's citizenry through psychological means. This article puts proposed behaviour-altering neuroscience weapons into their appropriate technical, historical and geopolitical contexts to present a sober and critical analysis of the threat arising from the weaponisation of behavioural neuroscience. It argues that by using psychiatric drugs, brain stimulation, brain imaging or neurobiochemical weapons, states may be able to leverage neuroscientific advances to influence, control and manipulate human behaviour and cognition. However, these approaches are extremely nascent and face technical and operational challenges that make their deployment difficult. Despite this, in consideration of the rapid pace of scientific advancement, growing geopolitical instability, and ambiguities in international law, scientists and the international community must remain vigilant as these technologies become more refined and the practical barriers to use begin to lower.*

Keywords: Behavioural neuroscience; pharmaceuticals; dual-use; neuroweapons; biological weapons; biosecurity

Weaponising neuroscience

Behavioural neuroscience studies the biological mechanisms that govern the very aspects which make us human – our emotions, memories and cognitive processes – and how they can go awry and cause mental diseases. This subfield of neuroscience has been transformed in the last 30 years by a flurry of seminal experiments exposing how the brain works with greater clarity than ever before. While we are far from a complete scientific understanding of the brain and all its functions, scientists are starting to understand how biochemical and electrical signals transferred between neurons form closed circuits and give rise to the sensations of fear, anxiety, trust and even love (Yuste 2015). With this new knowledge of the subcellular reactions that contribute to human behaviour also comes the ability to exogenously control them. Scientists have harnessed this power to revolutionise the treatment of mental illness. Because of the new and refined understanding of the specific neural networks governing behaviour and cognition, psychiatric drugs and brain stimulation methods targeting atypical biochemical signalling associated with mental illness are becoming more specific and effective. Similarly, through the correlative power of brain imaging, researchers have been able to detect brain regions that are abnormally active following brain injury or disorders, enabling them to more precisely target that region.

Troublingly, however, the alteration of brain chemistry by neuroscientists and physicians can not only treat mental illness, but also produce it. In addition to treating anxiety, depression or mania, psychiatric drugs targeting the same behavioural circuits can make a person experience these emotions. Moreover, brain stimulation at key points following an event show an emerging capability to enhance or delete memories, and brain imaging can provide insight into a person's cognitive processes or beliefs, potentially providing a new form of intelligence: 'NEURINT' (Wurzman and Giordano 2014). Controlling behaviour, or altering memories and cognition, has obvious intelligence and military value. The allure of the militarisation of behavioural neuroscience can be attributed to its ability to enable the proliferation of novel weapons of influence that facilitate the changing of hearts, minds or political perceptions of actors by invoking behaviour-altering emotions.

Propaganda, the selective release of information, and shows of military force have consistently been used throughout history to shift the perception of a conflict and, ultimately, the tides of war. The venerated masters of war and strategy – ranging from Sun Tzu to Clausewitz, and Napoleon to Patton – have all asserted that successful military campaigns must contain an element of coercion and psychological manipulation to degrade morale (Boyd 1987). The battle of Stalingrad, fire-bombing of Dresden, Vietnam War, and the Global War on Terror have all failed despite impressive demonstrations of military might (Szafranski 1997). Conversely, small, ill-equipped forces have overcome international Goliaths by understanding and manipulating the cultural and cognitive variables contributing to the decision to fight or to surrender (Szafranski 1997). The ability of a nation to sway the opinions of adversarial individuals, decision makers, armies or whole societies about the costs and benefits of a conflict is the decisive factor which prevents a stronger force from succeeding or allows a weaker force to prevail.

Influence is not limited to conflict, but is also used by numerous security services to massage information out of an obstinate person who possesses intelligence, or by police to illicit confessions from suspected criminals. Expert interrogators are trained to use subtle psychological manipulation and conditioning to create an environment where a person feels it is in their best interest to cooperate with investigators (Leo 1994). Interrogators employ a range of techniques to consciously manipulate the suspect’s emotion, attitude and even thought-processes to make the suspect feel powerless in attempts to facilitate the flow of information (Royal 1976).

Despite the importance of influencing an enemy in war, traditional weapons of influence have so far been more art than science. A heightened emotional intelligence coupled with a refined understanding of the target’s culture, morals and values, are required to design effective influence operations and conduct interrogations which yield accurate information from an obstinate subject. Nontherapeutic application of behavioural neuroscience methods has potential to change this paradigm and allow weapons of influence to be wielded with unparalleled efficiency. Hijacking the biological basis of behaviour could potentially achieve the same effect as a traditional weapon of influence – the creation of emotions which cause a shift in the response to, or perception of, an issue – but in a standardised and predictable way.

Assertions of the potential use of behavioural neuroscience would almost seem farcical if it were not for a long and dark history of government-sponsored attempts to attain the holy grail of influence: control of the mind. Most notoriously, the CIA’s MKULTRA mind control programme – in operation from the early 1950s through the mid-70s – focused on the development of emotional manipulation methods to make a person more amenable to intelligence questioning, to brainwashing or to forcing action in the interests of the United States (Inouye 1977). Similarly, Soviet and Chinese security services engaged in practices that were focused on indoctrination, cognitive degradation and development of more salient torture methods (Moreno 2006:73-78). Scientists from all sides used barbaric techniques such as sensory deprivation, hypnosis, physical torture and mind-bending drugs in attempts to force others to cooperate with intelligence agencies, erase memories or create spies who could collect information on foreign adversaries or carry out assassinations (Marks 1979; Moreno 2006:61-82).

The common thread throughout the American, Soviet and Chinese mind control programmes was the pursuit of scientific methods of exerting influence and coercion on others. These programmes were ultimately seen as failures because of a lack of scientific understanding of the precise physiological mechanisms underpinning the aspects of behaviour that each state was interested in manipulating. But, neuroscience now appears to be breaking down the previous technical barriers to control the mind at an unprecedented rate. The ability to selectively control neural circuitry and observe it in action seems to be bringing within arm's reach the ability to exogenously control the mind and to subsequently influence, coerce and manipulate behaviour.

The potentially serious strategic ramifications of the weaponisation of neuroscience has resulted in a proliferation of commentary on neuroscientific threats, needed ethical frameworks, and possible proliferation-control regimes (e.g. Dando 2015; Giordano 2014). Numerous high-profile reports have cited growing military applications of neuroscience (Royal Society 2012; National Research Council 2014, 2008). However, in these threat analyses, there is a growing divide between claims of neuro-threats and empirical practicalities.

A lack of technical, historical and geopolitical context has contributed to sensationalism and to the blurring of clear analysis. Is there actually a threat of states developing mind control capabilities using behavioural neuroscience? If so, can we expect to see it anytime soon? This article adds to the burgeoning critical literature analysing the security implications of developments in the life sciences by mapping state-of-the-art neuroscience research and bridging the widening gap between perceived threats and on-the-ground realities. We assess four different neurotechnologies in turn: psychiatric drugs, brain stimulation, brain imaging or neurobiochemical weapons. We find it is technically possible to alter brain chemistry in order to introduce novel emotion, cause cognitive shifts and affect behaviour. However, endeavours to biochemically or electrically control the mind will likely be limited for similar reasons to previous attempts: neuroweapons are extremely difficult to operationalise in practise. Despite this, in consideration of growing geopolitical instability and ambiguities in international law, scientists and the international community must remain vigilant as these technologies become more refined and the practical barriers to use begin to lower.

A critical approach

Many of the works on national security implications of neuroscience consider the science to be fully formed, and ready for use. This is not the case. Even though neuroscientists have greatly improved our knowledge of the brain, there is still much to be desired.

As Marks (2010) points out, the technocratic and discipline-specific language used by both scientists and defence officials prevents critical and clear-eyed engagement with the national security implications of neuroscience and has contributed to growing dissonance between the assessed dual-use threat of the field and technical realities. Many of the claimed abilities thought to be rapidly approaching are over-hyped and divorced from the technical limitations and practical struggles that neuroscientists would have to overcome to even attempt to control someone else's mind, implant memories or peer into someone's cognitive processes (Caulfield, Rachul and Zarzeczny 2010). In reality, predicting the outcome of a drug, or using brain imaging to read someone's mind, is still very difficult, and promising experiments are often limited to strictly controlled laboratory conditions and have not been tested in operational scenarios (Illes et al 2010). Choudhury, Nagel and Slaby (2009) argue that a critical approach can defuse unnecessary hype and enable the necessary informed and sober study of the security implications of neuroscience.

'Critical neuroscience' analysis supplements a growing call for a critical approach to studies of national security implications of advances in biomedical research and the life sciences that contextualises developments within historical pursuits of the science, the socio-political drivers of the research, and the technical limitations. Early pioneers were Ben Ouagrham-Gormley and Vogel, who demonstrated, on the basis of their in-depth analysis of the historical US and Soviet biowarfare programmes, that there are important intangible barriers to the proliferation of biological weapons, and that 'tacit knowledge' has been marginalised in assessments of the dual-use threat of biotechnologies in the twenty-first century (Ben Ouagrham-Gormley and Vogel 2010; Ben Ouagrham-Gormley 2012; Vogel 2013; Ben Ouagrham-Gormley 2014). Drilling down on one of the key emerging biotechnologies, Jefferson, Lentzos and Marris (2014) analysed the pervasiveness of naïve, simplistic and misleading assumptions about synthetic biology in policy discussions on its dual-use threat, categorising them into five 'myths.' Their work also drew out some of the subtleties that frequently disappear from policy discussions, demonstrating how "the simplistic and discredited linear model of innovation that underscores the dominant understanding of the dual use threat posed by advances in the biosciences leads to an over-estimation of the smoothness and ease of innovation for biological weapons development" (Marris, Jefferson and Lentzos 2014: 424). This is important, because exaggerated concerns about the misuse potential of synthetic biology in turn "direct the policy gaze towards measures that, on their own, have limited effects on security" (Marris, Jefferson and Lentzos 2014: 423).

This study draws on empirical and peer-reviewed neuroscience research, in conjunction with historical and geopolitical analysis, to discuss the potential for converting clinical uses of behavioural neuroscience to the battlefield. The article assesses these issues on two levels. We first examine the class of neuroweapons aimed at the individual, specifically considering the use of psychiatric drugs and brain stimulation. We then discuss neuroscientific influence weapons as they may be used against societies and armies. Here, we focus on brain imaging and neurobiochemical weapons. The particular neurotechnologies examined in the article are not inclusive of all neurotechnologies that can be used to influence human behaviour, or indeed of all weapons which leverage neuroscience towards militant ends. The specific cases were chosen because they are currently the most widely discussed in policy circles and in the emerging neurosecurity literature. The specific cases also most closely parallel previous state attempts at developing mind control capabilities.

Psychological torture, brainwashing, and mind control

The post-9/11 era has been marked by a perception that threats of terrorism are both urgent and unpredictable. With determination to prevent another domestic mass casualty event, US Armed Forces and the CIA employed so-called 'enhanced interrogation techniques' (EITs) throughout the early 2000s to extract information from al-Qaeda affiliated enemy combatants at the Abu Ghraib and Guantanamo Bay Detention facilities. Prisoners were subjected to open-handed slaps to the face and abdomen, forced standing in stressful positions for long periods, sleep deprivation, cramped confinement, prolonged nudity for weeks or months, and, most infamously, waterboarding (Central Intelligence Agency Inspector General 2004; International Committee of the Red Cross 2007). These EITs, however, were not born out of sadism, but were systemically designed with the intent of producing and controlling certain emotions – stress, anxiety, and confusion – that are thought to make a person more amenable to surrendering information (International Committee of the Red Cross 2007; Central Intelligence Agency 1985). The focus on prisoner psychology is not unique to US interrogation programmes. Across almost all instances of physical torture, there is a consistent goal: to control a prisoner's mental state by manipulating their external perceptions and sensations with the hope of forcing him or her to cooperate and provide information.

Indeed, several nations have engaged in sophisticated research aimed at the design of methods that could more quickly and efficiently control emotions and behaviour. Throughout the Cold War, the US, USSR, and China engaged in wide-ranging programmes aimed at providing each state with powers of irresistible influence over captive individuals. Mind-bending drugs, violence and stress-inducing sensory stimulation and deprivation were used in attempts to manipulate the behavioural state and to remotely control the bodies and minds of prisoners. Ultimately, however, these efforts were seen to fail because of an incomplete understanding of the factors at play in the brain which required specific attenuation.

Advances in behavioural neuroscience are now rapidly changing this situation. Psychiatric drugs which have been developed for therapeutic uses often result in side-effects which can affect mood and behaviour. Moreno (2006:171-72) and Thomsen (2014) propose that when used non-therapeutically, these affective off-target effects can be used to exogenously produce many of the same emotions that are thought to be useful in interrogations. Similarly, brain stimulation methods show increasing promise –and risk of weaponisation (Fisher 2010). In line with mind control pursuits of the past, brain stimulation is emerging as a method that can be used to delete memories, control another's body, or incept thoughts. Emphasis on worst case scenarios of the application of drugs and brain stimulation has resulted in an uninformed and inflammatory debate. In this section, we review the implications and practicalities of interrogation drugs and brain stimulation within its historical context. By evaluating US, USSR, and Chinese attempts at behavioural control, we argue that, despite promise, scientists and security officials still face the same challenges they encountered in the similar 20th century research programmes, and that these challenges will likely continue to inhibit their use in the future.

Mind control: Ambitions and attempts

The EITs developed by the CIA to extract information from Guantanamo prisoners drew on an understanding of prisoner psychology developed from US attempts throughout the 1950s, 60s, and 70s to exogenously modify behaviour in others (Moreno 2006:68-76). During this time, there were fears in both the US and USSR that the other side may be the first to militarise the mind and monopolise the ultimate battlefield. Most infamously, many of these programmes involved attempts to use paranormal phenomenon and psychic powers to control others. However, the primary focus was on determining and producing psychological states which made a person susceptible to new ideas, enabling the turning of agents or the degrading of a person's ability to lie or resist questioning.

The USSR was one of the heaviest investors in behavioural control research. Throughout Russian and Soviet history, deception, incepting thoughts and manipulating perceptions were central fixtures used by the government to maintain influence and power. Today, controlling the mind – albeit through influence operations and active measures – are still widely used tools of Russian statecraft and domestic politics (Adamsky 2015). Thus, Soviet interest in standardised methods to control the mind is not surprising. While the Soviet's mind-control programme remains opaque to Western historical analysis – in part due to language barriers, and in part because of the dearth of open information – a 1972 declassified DIA report entitled *Controlled Offensive Behavior – USSR* describes how starting in 1932, Soviet security services falsely diagnosed political dissidents with mental illness so they could be legally sent to psychiatric hospitals, and 'treated' with high doses of psychiatric medicines in concert with a variety of methods such as flashing lights, sensory and sleep deprivation, the application of electronic and magnetic fields, hypnosis, and paranormal phenomenon in attempts to disorientate, confuse, and incite anxiety (LaMothe 1972). The DIA assesses that in this state of artificially-created psychosis, guards were not only able to get intractable prisoners to cooperate in interrogations, but also to confess to almost any crime to discredit their own views and those of other dissenters (LaMothe 1972).

We can never know whether the guards were truly successful in this brain washing exercise, or if, as the DIA claims, the prisoners, were ultimately broken and submitted to the will of their captors to end the torture. Regardless, these practices were taken up and modified by the Chinese during the Korean War in the early 1950s (Moreno 2006:66-68). By combining the manipulative Soviet interrogation practices utilizing extreme sensory stimulation and deprivation to create a fragile emotional state with their relatively advanced pedagogical techniques, the Chinese were able to coerce the majority of their US and UN force prisoners into confessing to their 'capitalist crimes,' disclosing intelligence to interrogators, and participating in tasks intended to indoctrinate the prisoners with Maoist ideology (Moreno 2006:66-68). A post-repatriation psychological examination and survey of prisoners held by the Chinese army reveals that POWs were exposed to extreme hardships, the cyclical alleviation and reactivation of fear, and mind-bending drugs designed to create a sense of despair and helplessness in order to produce a malleable and desired psychological state (Schein 1956). It was explicitly communicated to the prisoners that these hardships would come to an end if they cooperated with their captives (Schein 1956). While interviews with POWs did not seem to show any immediate evidence that the Chinese were effective in their brainwashing attempts, there was concern by US Army psychologists that the effects could be delayed or remotely triggered, and that they were thereby undetectable in the near term (Schein 1956). US officials feared that these prisoners could be activated remotely via a cue and be turned into spies or assassins.

What started as a defensive CIA programme focused on understanding and countering the psychological tactics of the Soviets and Chinese quickly evolved into wide-ranging and well-funded research into techniques to control human behaviour through unconventional means (Marks 1979). Not only did the CIA seek to extract information from difficult prisoners, but they also sought to psychologically manipulate Russian and Chinese immigrants into acting as foreign agents and doing the bidding of the United States (Moreno 2006:67-76). MKULTRA[1] – the name given to the CIA's mind control programme –focused on the effects of alcohol and behavioural drugs in interrogations, unconventional communication via telepathy or psychic connection, hypnosis to force another to do something against his or her will, counter-torture and counter-brainwashing methods, the production of selective amnesia, and covert administration of mind-bending drugs such as heroin, marijuana, and most infamously, truth serums and LSD (Inouye 1977).

While many of the more unconventional and bizarre projects enveloped under MKULTRA, such as remote viewing, psychic interrogation or hypnosis, were assessed to have low likelihood of operational success, the CIA saw the use of psychedelic drugs, such as hallucinogenic mushrooms, marijuana, heroin, LSD and truth serums, to alter cognition and behaviour as a potential aid in interrogations or to selectively make someone forget a memory or an event. From this programme – and the Russian and Chinese programmes like it – the CIA learned a great deal about human behaviours –and how to manipulate them –which to this day is still drawn upon in collecting human intelligence.

Coming down from a high: Why MKULTRA failed

Despite new insights into the darker sides of human emotion, Project MKULTRA ultimately became regarded as a failure. The CIA ended the programme in the early 70s, assessing that behaviour-controlling drugs were not operationally useful in changing previously held views or in coercing potential intelligence sources into cooperation (Inouye 1977; Marks 1979:144-62).

New pharmaceuticals, however, appear to be changing this dynamic. To understand the threat arising from new drugs which can alter behaviour, it is helpful to evaluate the factors which led to the failure of MKULTRA. The effects of interrogation drugs – the central and most serious focus of the MKULTRA programme – were too unpredictable and variable. Moreover, the use of drugs in interrogations required high levels of operational security which resulted in the perception by intelligence officers that their use was too much trouble considering the little benefit they seemed to provide (Marks 1979:144-62). Practical considerations aside, the two most aggressively researched interrogation drugs: truth serums and LSD were evaluated as being more detrimental to the interrogation process than they were helpful.

For example, 'Truth' drugs – most notably scopolamine, and the barbiturates such as sodium pentothal, and sodium amytal – are central nervous system depressants that do not compel a person to tell the truth, but akin to a state of drunkenness, make a person less inhibited, more talkative, and *less likely* to lie (Lowry 2008/2007). Scopolamine was initially used as an anaesthetic during childbirth. It was quickly transferred to psychotherapists and subsequently, the intelligence community, after physicians noticed that women revealed aspects of their life that they otherwise would not have while on the drug (Lowry 2008/2007). After extensive testing, however, Scopolamine was disqualified as a truth drug by the CIA because several of its side effects – hallucinations, disturbed perception, drowsiness, headaches, blurred vision, and an extremely dry mouth to the point that it was impossible to speak – inhibited the disclosure of information (Bimmerle 1993).

Barbiturates did not fare much better. Experimental administration of sodium amytal to 17 US Army soldiers with military charges pending against them resulted in suspects revealing fantasies, fears and delusions, as well as valid information to their interrogator (Gerson and Victoroff 1948). However, there was no way for an interrogator to distinguish fact from fiction (Bimmerle 1993). Nine of the 17 subjects confirmed that the information they gave under the influence of sodium amytal was truthful, while eight withdrew their confessions, leading the experimenters to conclude that sodium amytal may be able to reduce ambiguities in interrogations, but cannot eliminate them altogether (Bimmerle 1993). The drugs also made the subjects more suggestible and much more willing to say anything that he or she thought the interrogator wanted to hear (Bimmerle 1993). Most damning, additional studies demonstrated that it is possible for normal individuals without counter-interrogation training to lie while dosed with sodium amytal, limiting its usefulness for interrogation with foreign agents prepared with counter-interrogation strategies (Redlich, Ravitz and Dession 1951). The truth serums made the job of an interrogator more difficult and quickly fell out of fashion.

Similarly, attempts to use LSD to make an interrogee vulnerable to questioning also yielded nothing but frustration and failure. LSD was thought to release memories, reveal the unconscious, and bring new levels of awareness to the intoxicated (Dyck 2005). The CIA became interested in LSD after discovering its ability to distort reality and perceptions, and to produce symptoms of schizophrenia and madness. The rationale was that the exogenously induced psychosis would make those dosed with the drug vulnerable to CIA intelligence officers (Marks 1979:39-55). While it was not seen as useful for extracting the truth due to its hallucinogenic and reality-bending effects, a declassified CIA assessment notes that an adversary may use it to induce anxiety or confusion, or as used by the Russians, to trick a subject into believing that they are experiencing psychosis and compel cooperation (Bimmerle 1993).

Following repeated trials, LSD and similar drugs thought to control behaviour were quickly perceived as a hindrance, rather than aid to the collection of useable intelligence. These drugs often resulted in the inability of a respondent to string together complete thoughts, and indecipherable responses to questions (Bimmerle 1993). Interrogators needed to work harder to move questioning along in a linear fashion and constantly had to redirect the intoxicated subject. Interrogators also had to carefully ensure that their line of questioning did not introduce new ideas or cues to their now extremely susceptible, drugged subjects (Bimmerle 1993). Indeed, interrogators were required to demonstrate advanced skill to discern correct information from false information, and often had to use even more sophisticated psychological tricks to induce a drugged subject into cooperation (Bimmerle 1993; Lowry 2008/2007). After the drug had run its course, the internal revelation that a prisoner had been drugged often resulted in variable effects in their willingness to continue to cooperate, or sometimes in the subject hardening themselves against the drug's effects in subsequent dosing, necessitating covert administration (Redlich, Ravitz and Dession 1951).

Rather than stream-lining the interrogation process and allowing the extraction of information with greater ease, when using interrogation drugs, intelligence agents actually had to work harder to obtain accurate information, defeating the purpose of using the drug and giving them little – if any – practical utility.

From truth serum to neuroscientific control?

Despite the failures of MKULTRA, the promise of behavioural neuroscience has reintroduced interest in the use of drugs and other neuronal technologies to control and influence behaviour. Several have pointed out that the discovery of neuronal circuits associated with basic human emotions can lead to the creation of new biological and chemical weapons which target the central nervous system and influence and manipulate behaviour in a discriminatory fashion (Dando 2015; Thomsen 2014; Royal Society 2012). New pharmaceuticals can make a person more trusting, willing to talk, or akin to traditional methods of physical torture, induce fear, anxiety, stress, and confusion (Crockett and Fehr 2013). Unlike past attempts at drug-induced mind control, the efficiency and specificity with which these new psychiatric drugs can affect the brain potentially make them much more operationally tempting.

Outside manipulation of neural circuitry controlling behaviour is already a medical reality. Behaviour-controlling drugs are readily available, and in many cases, have been rigorously tested and approved for human use. For example, selective serotonin reuptake inhibitors (SSRIs), such as Prozac, Zoloft, and Citalopram act as a serotonin agonist by preventing its reabsorption following an action potential, and increasing serotonin-initiated neuron transmission. While commonly used to treat depression, increasing serotonin transmission via SSRIs has been positively correlated with prosocial behaviours and cooperation which may be useful in a questioning session (Crockett and Fehr 2013).

Moreover, numerous classes of widely available psychiatric drugs are known to induce the same behaviours which have traditionally been the goal of many torture programmes – without leaving any cuts or bruises. For example, Eurgeronics such as modafinil, the drug commonly prescribed for narcolepsy, are known to produce anxiety, nervousness, and confusion, and the Benzodiazepine class of drugs can generate depression, confusion and memory loss as side-effects to their therapeutic uses (Wurzman and Giordano 2014:98).

Dietary modification also shows increasing promise for the exogenous manipulation of neurochemical signalling. Recent work in the effects of the microbiome – the bacterial flora located in the human gut traditionally thought to aid in digestion – on brain chemistry shows significant potential for covert alterations of neurotransmission. Researchers have found that psychiatric illnesses are commonly coupled with abnormal GI pathology, and that intestinal bacteria play a significant role in the development and response of the immune system, which may indirectly affect neurotransmitter concentration and shape behaviour (Vandvik et al 2004; Dantzer et al 2008; Sampson and Mazmanian 2015). By changing the diet of a person, or mouse, to alter the relative concentrations of gut microbiota, researchers have been able to produce anxiety and increase and intensify the hormonal stress response in both humans and mice (Messaoudi et al 2011; Bercik et al 2011; Selkrig et al 2014; Sudo et al 2004; Sampson and Mazmanian, 2015). Moreover, alteration of the macronutrients contained within food can also be used to affect the concentration of metabolic precursors to neurotransmitters and subsequently cause behavioural changes through the alteration of neural transmission (Crockett and Fehr 2013).

This growing body of knowledge has interesting implications considering the past willingness of states to alter the food supplies of their enemies. In WWII, for example, the US attempted to lace Hitler's food with female sex hormones to push him over the gender boundary (Marks 1979:12). Similarly, a defining characteristic of South Africa's biological weapons programme was the disguise of deadly microbes into food products for use in assassinations (Hay 2016). Interestingly, while being interned in Chinese prisons, Korean War POWs reported that the food they were given was one of the worst aspects of their treatment (Schein 1956). The psychiatric links to gut microbiota offer a possible explanation for this effect. By leveraging burgeoning knowledge of the connections between the brain and the gut, a state may be able to covertly control the neurochemistry underlying behaviour, limiting the sometimes-violent reactions that drugged subjects have and inhibit a prisoner's ability to undertake counter-interrogation measures to interrogation drugs.

Pharmaceutical modulation of behaviour is still hard

Despite the increasing efficiency and specificity with which new psychiatric drugs can affect the brain, and the seeming ease with which neurochemistry can be altered, states seeking to use these capabilities in pursuit of behavioural control and manipulation still face technical and operational challenges. Several of the purported abilities that would be favourable to an interrogator of many of the widely-available drugs on the market are side-effects of a primary action. These effects are not guaranteed and may be more prevalent in some people, and non-existent in others. The precise pharmacological mechanism of action for many drugs is still poorly understood and it is common for psychiatric medicines to have large variations in efficacy across populations due to anatomical and genetic variations, as well as individual family and medical history. Drug dosage also plays a significant role in determining the effects of a drug on behaviour. For example, by changing the dosage of SSRIs, researchers have found they can increase serotonin transmission at presynaptic receptors at low doses, and post-synaptically by high SSRI dosage (Selvaraj et al 2012). The increased transmission at different cellular locations can yield different effects.

Furthermore, neurotransmitter concentration in a specific location is naturally regulated based on the needed transmission or outcome at the time. However, outside manipulation of brain chemistry by psychiatric drugs increases the concentration of the neurotransmitter without discrimination and can initiate multiple or even opposing effects of receptor subtypes (Crockett and Fehr 2013). While it is feasible to synthesise a drug that is selective for one neuron receptor subtype, receptors are distributed throughout the body, further increasing the probability of undesirable side-effects. At present, it is not possible to un-invasively control neurotransmitter concentrations at a specific neuronal nucleus and produce desired effects, while eliminating others. Of course, this issue is not applicable to all classes of neurotransmitters and their receptor subtypes. Activation of multiple receptors throughout the brain may produce no, or even desirable effects depending upon the neurotransmitter being pharmaceutically manipulated.

Medical and family history can also seriously affect both the short and long-term outcomes of behavioural control. Drug interaction with medications that a prisoner may already have taken may prove lethal. There is also increasing evidence that genes and even family members' past experiences may change a person's susceptibility to mental disease. For example, a study on the intergenerational transmission of memory in mice found that fear memories can be transmitted to progeny via epigenetic modifications and persist for up to three generations (Dias and Ressler 2014).

There is no wonder drug, and just as the clinical treatment of a psychiatric disease requires a prolonged regimen of trial and error to find a medicine that both treats the symptoms of a disorder and has acceptable side-effects, depending on the desired effects of 'treatment' a medicalised interrogation will have to similarly engage in an individualised trial and error process to find the appropriate drug or dietary modification regime to enable behavioural control, introducing significant complications to the interrogation process.

Even so, the bespoke process needed to implement drug-aided interrogations is a nuisance, rather than a barrier to entry. Throughout past torture programmes, methods were not standardised, but individually designed to maximise psychological impact for each prisoner. For instance, in the design and implementation of post-9/11 EITs, the CIA compelled behavioural scientists to find psychological weaknesses or phobias specific to each prisoner which could be exploited (Bloche and Marks 2005). Some prisoners were made to listen to unfamiliar and culturally distressing music, while others were made to observe the mishandling of the Quran – considered sacrilege by devout Muslims (Blakeley 2011).

Ultimately, behavioural drugs can be used to the same ends as the CIA's EITs: behavioural control. Just as the bespoke nature of EITs makes them time-intensive and not suitable for widespread use, the difficulties of using interrogation-aiding drugs makes them only suitable for the most intractable and high-value targets. The need for lengthy trial and error may soon disappear. Developments in genomic-based medicine are making it easier to predict patient response to drug treatment for psychiatric disease (Ozomaro, Wahlestedt and Nemeroff 2013). As genetic sequencing becomes faster and cheaper and the field of pharmacogenomics matures, doctors may be able to use a patient's genetic profile to match a person to the appropriate drug. Similarly, it becomes more plausible that states seeking to use drugs in interrogations can obtain a blood or saliva sample from a prisoner to predict the effects of a drug on an individual.

Using brain stimulation to alter memories and ideas

Brain stimulation is also showing increasing promise for its ability to alter the electrical conduction patterns of neurons. There are numerous stimulation approaches – some of which, such as deep brain stimulation (DBS) have already been approved for the treatment of Parkinson's disease and depression (Mayberg et al 2005). Of more interest are emerging stimulation approaches such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) which noninvasively attenuate neural transmission (Sparing and Mottaghy 2008). Yet, the non-therapeutic uses of brain stimulation are becoming more evident (Levasseur-Moreau, Brunelin and Fecteau 2013). A growing body of research leveraging new techniques are starting to demonstrate a nascent ability to alter memories, control the body, and introduce ideas directly between brains.

In 2013, Ramirez et al released a landmark paper where they used intracranial optical stimulation of hippocampal neurons to introduce a false memory of fear to a mouse (Ramirez et al 2013). While rudimentary in nature, this experiment demonstrates that memories can be manipulated by altering the firing patterns of key neurons. Building on this experiment, Deadwyler et al (2013) showed that memories can also be transferred between animals. By extracting and transmitting firing patterns observed while an animal was encoding memories to an untrained rat, recipients could successfully perform tasks where it had to utilise the memory that was transmitted to them (Deadwyler et al 2013). While these experiments used stimulation probes requiring surgical implantation, the emerging ability to incept memories is reminiscent of Chinese and Soviet attempts to brainwash and introduce new ideologies to prisoners.

As Spiers and Bendor (2014) note, our memories ultimately define us and our global outlook. By altering memories, a state may be able to change individual alliances, long-held beliefs on morality or ideology, or even a person's conception of their own identity. Manipulating the memories of rats, and people, however, is a rather large leap. How specific memories of information are encoded in the brain is still poorly understood. Extracting the correct information and tying it to an emotion which compels action – especially in violation of already-held beliefs such as loyalty to one's country or the morality of murder – will prove to be even more challenging. The enhancement of memories by TMS and tDCS is more plausible. Several groups have used TMS and tDCS to enhance short-term working memory and speed of recall (Gazzaley et al 2005). In this regard, there has been interest by states seeking to enhance the cognitive capabilities of their forces, but the offensive applications are minimal (National Research Council 2008).

Brain stimulation also ostensibly provides new approaches to link brains together in brain-brain networks, which are showing a nascent ability to control the body and influence the mind. These networks have been created by scientists who use an electroencephalogram (EEG) to record the electrical activity of the brain of a ‘sender’ which is then transmitted via the internet to the ‘recipient.’ The recipient subsequently receives tDCS to decode and interpret the message recorded from the sender. Scientists have also shown it is possible to non-invasively transfer information between human brains. In a seminal brain network experiment, electrical activity correlating to motor movements associated with communication (e.g. mouth or tongue movements to form syllables and words) were recorded and transmitted directly into the brain of someone on the other side of the world (in this case, the sender was in India, recipient in France) (Grau et al 2014). The senders successfully transmitted words to the recipient without actually speaking. Using the same technology, a group at the University of Washington also demonstrated that a sender can share sensory information with a recipient to facilitate cooperation in video game play using a paradigm where only the sender could see the monitor and the recipient had the control (Rao et al 2014). The sender was able to communicate to the recipient when it needed to fire a missile at a fictional alien spaceship invading earth.

The military applications of the brain-brain networks are evident. At a more benign level, a more refined inter-brain communication has potential to revolutionise command and control. But more malignant uses of this technology are easily conjured. Brain network researchers suggest that this system could ultimately result in one-way transmission of emotions and feelings between individuals (Grau et al 2014). The unilateral flow of emotion or ideas will enable manipulation at never before seen levels. If a person unwittingly becomes a recipient in a brain-brain network, then planting thoughts *theoretically* becomes quite easy. At present, however, brain network researchers note that the low bit rate of data transfer between people limits the use of this as a communication system.

Regardless of the burgeoning capabilities of brain stimulation, it is currently limited to the laboratory environment. The experiments described here involving humans are divorced from the real world by design and are not generalisable to operational environments (Fisher 2010). There are a multitude of factors – stimulation intensity, duration, location – which must be controlled to yield marginal changes in neural stimulation (Fisher 2010). Stimulation of deep brain regions still requires surgical placement of probes, further complicating military use. Moreover, the long-term effects and specificity of brain stimulation are currently unknown and further complicate its use (Sehm and Ragert 2013). Similar to pharmaceutical manipulation of brain chemistry, it is not easy, nor feasible to use brain stimulation to manipulate and control in a predictable fashion.

Whether through psychiatric drugs or brain stimulation, altering the neuronal signalling of another is possible and can enable behavioural control, and increasingly can affect memory and cognition. Yet, this has been tried before, and previous attempts were abandoned for the same reasons that future ones likely will: mind control simply is not operationally practical. Drugs which can alter emotion or perception to aid in an interrogation are still too variable, and come with unwanted side effects. Moreover, brain stimulation to enhance and delete memories, or incept ideas, is far too nascent to be used outside the laboratory towards these ends. Military and intelligence conversion of these technologies is difficult, but not impossible.

A wider net for influence and coercion?

Thus far, we have discussed the ability to control and manipulate the behaviour of individuals in intelligence interviews and to create foreign agents which are forced to act against their will. Yet, the individual is not the only target of neuroweapons. Neuroscientific weapons of influence can also target groups of people. They can revolutionise psychological operations and propaganda to change perceptions and subsequent political desires of a population, or be used to create a new class of biochemical weapons which can degrade or enhance the morale or ability of a force to fight (Royal Society 2012). Here, we dissect the feasibility of using brain imaging and neurobiochemical weapons (NBCWs) on the battlefield. Akin to the previously discussed individually-focused neuroscience weapons, the technology is readily available. However, its practical utility is left in question. Group-focused neuroscience weapons present an interesting conundrum because unlike the neurotechnological applications focused solely at individuals, this class of influence weapons is seen as benign, or even preferable to conventional approaches, and thus their use may be seen sooner, rather than later.

Brain imaging, for instance, is a non-invasive and low-risk method which can be used to pre-emptively test the psychological effects of an influence operation. While brain imaging presents interesting challenges to individual privacy, the militant application of this technology does not immediately cause the same repulsion as attempts to control another's neural signalling. Similarly, NBCWs – weaponised psychiatric drugs and bacterium or parasites which attack the nervous system – are gaining popularity because of their reputation for being non-lethal incapacitating weapons, and thus more humane than conventional weapons.

A new and improved PSYOP? The fMRI and neuro-intelligence

Regardless of the context or desired strategic outcomes, wars are won and lost by the ability to coerce an opponent into thinking that resistance is not in his or her favour. Thus, the penetration of the collective psyche and the psychological operation (PSYOP) is an utmost consideration of many conflicts. US military doctrine defines a PSYOP as an operation with the explicit goal of reducing the morale and combat efficiency of enemy troops, creating dissonance within their ranks, promoting resistance within a civilian population against a hostile regime, and to convince both friends and foes alike to take actions which are in the interest of the US and its allies (Goldstein and Findley 1996). While a PSYOP is usually thought of as being limited to propaganda films, artwork or radio shows and the strategic release of (dis)information to sway public opinion, any military action – or terrorist attack – designed to 'win hearts and minds' or 'shock and awe' can be viewed through the lens of a PSYOP (Szafranski 1997).

Despite their importance, PSYOPs are poorly understood and are widely disparaged in the West due to their inability to guarantee quantifiable and predictable results (Goldstein and Findley 1996). A bomb is lethal to those it is dropped on, but its wider psychological effects may be unknown or contradictory to the goal of a military campaign. Further, traditional PSYOPS are almost always conducted in complex environments which make it hard to conclude with certainty that a PSYOP has worked, or is responsible for military or diplomatic developments. Most significantly, effective PSYOPs which resonate with the target population are incredibly difficult to design (Goldstein and Findley 1996). They require a nuanced understanding of the target society's culture, including collective values, identity and decision-making processes (Goldstein and Findley 1996). However, if a state does not possess this understanding of its audience, it cannot hope to influence it.

Functional magnetic resonance imaging (fMRI) may be able to provide solutions to these problems (Wurzman and Giordano 2014: 93-96). Recently, fMRI has enabled scientists to analyse how brains respond to different ideas and has given specific insight into a group's collective identity and culture (Berns and Atran 2012). While not traditionally thought of as such, culture and biology are deeply intertwined (Berns and Atran 2012). Physiological responses to various scenarios are inseparably linked to our understanding of the world, how we make decisions, and the systems through which we distinguish friend from foe. When questioned about the existence of God, for instance, a religious person's and atheist's physiological responses demonstrate different levels of anxiety and distress – the religious person experiences decreased anxiety, while the atheist's brain shows neurophysiological markers of distress (Inzlicht and Tullett 2010). While the cause of the activation is the same – there are no biological differences between the two groups that would cause them to respond differently to the concept of God – differences in cognitive decision-making and emotions arising from pre-existing values are responsible for the different activation of biological markers (Berns and Atran 2012). How a person perceives God changes their biological response to spiritual reflection. fMRI studies use this principle to attempt to obtain information about a group's cognitive processes and culture.

Magnetic resonance imaging (MRI) uses a large magnet to alter the spin of protons contained within hydrogen nuclei and induce vibrations which then can be recorded to produce images of various internal physiological structures (Deichmann 2009; Logothetis 2008). Functional imaging (fMRI) differs from standard MRI because rather than taking static images, the fMRI measures changes in blood flow to brain areas in real time, which is then used as a proxy to quantify regional activation (Deichmann 2009). Linkage of activation in a single brain area is too one-dimensional to provide information on something as complex as emotion or cognition (Ariely and Berns 2010). Researchers, however, have discovered that there are reliable and consistent activation patterns across populations in response to varying events (Hasson et al 2004). Thus, the fMRI is a powerful tool because it allows scientists to establish baseline activation patterns for emotions or sophisticated cognitive processes and then use this aggregate data to correlate future fMRI images from different people to an emotion or cognition. The most alluring aspect of fMRI is that even if a person may not be able to articulate their feelings, thoughts or preferences on a subject, brain imaging offers correlative insight into these inner workings for researchers (Ariely and Berns 2010).

Unlike the traditional anthropological and sociological studies of a population, fMRI seems to enable a measurable PSYOP that allows for guarantees of success and measurable outcomes. Theoretically, a state could use fMRI studies to measure the relative levels of fear, aggression, or even more complex processes such as patriotism or devotion in response to a piece of propaganda or a simulated military strike. Thus, states could use this information to predict and optimise the effects of both psychological and military operations without having to rely on the inherent biases and security problems associated with interviews and surveys. Similarly, fMRI appears to provide insight into cultural phenomenon by elucidating what a group values, or the way they process decisions (Pincus et al 2014). This yields otherwise unobtainable information and has led Giordano and Wurzman to assert that fMRI can provide access to a holy grail of cognitive processes, which when statistically aggregated, can yield an entirely new class of intelligence: 'NEURINT' (Wurzman and Giordano 2014: 93-96).[2]

This claim is not completely without merit. While still at a developmental stage, DARPA's 'Narrative Networks' programme uses fMRI alongside other neuroimaging platforms to understand how radicalisation narratives and propaganda affect neurocircuitry associated with decisions about morality and how listening to a story can evoke emotion

(Sanchez 2017; Venkatramanan 2011). Ultimately, DARPA seeks to develop a closed loop system where neural responses to a story dictate plot trajectory (Miranda et al 2015). fMRIs can be used to develop a baseline for how the brain responds to different narratives which can then augment PSYOPs and information campaigns to produce the desired result. For example, if seeking to design a PSYOP which inspires fear or trust, scientists can theoretically use the fMRI to measure differences in brain activation in areas correlated with fear to determine what types of propaganda are the scariest.

fMRI has also been suggested as a tool for determining what lines should not be crossed by an actor seeking to influence a foreign and opaque culture. Experimenters reason that they can determine a person's sacred values based on fMRI scans correlating with deontological or utilitarian evaluation when asked to violate or trade away their beliefs for monetary gain (Berns et al 2012). The neural responses recorded from this study can then be extrapolated more widely to the population to discern between sacred and non-sacred values. The authors of this study claim that, based on this and similar experiments, governments can use fMRI in counter-radicalisation programmes to parse apart the principal values which motivate terrorists to continue in their mission, or to determine the collective values of a society, which if violated would result in a backlash from the civilian population (Giordano 2014; Astorino-Courtois et al 2017). To be certain, there is a technical – albeit methodologically limited – ability to collect NEURINT. However, examination of previous attempts by academics and marketers to use fMRI outside the laboratory demonstrate the difficulties a state may face if they attempt to establish a NEURINT capability.

Practical limitations of 'NEURINT:' A case study on neuromarketing

The designers of PSYOPs and marketers have much in common – they both seek to influence and change people's behaviour through their messaging. Following numerous experiments on the neural correlates of choice and economic decision making, neuroscientists and economists have come together to attempt to use fMRI to predict consumer behaviour and gave birth to neuromarketing (Morin 2011). Neuromarketers claim the ability to predict the popularity of a product by examining fMRIs of sample potential customers. For example, Berns and Moore (2012) found a *post hoc* correlation between neural activation in areas known to be related to future purchasing decisions and future album sales. These authors suggest that activation in the same areas to new songs will be predictive of future market success of the album (Berns and Moore 2012). Despite this, marketers have widely eschewed fMRI experiments in their product design and advertising life cycles for numerous reasons.

While these types of studies provide pretty images, whether fMRI marketing studies actually provide better information than traditional modes of market research (e.g. focus groups and market tests) is unclear (Ariely and Berns 2010). Neuromarketing techniques utilising fMRI are only able to distinguish subject preferences relative to the different options subjects are presented with, which still necessitates independent design, and trial and error. Moreover, unlike traditional methods such as focus groups or surveys, fMRI studies cannot tell market researchers if all the options presented are bad. The fMRI would be able to tell neuromarketers which of the options is the least terrible, but researchers will not be able to know that none of the advertisements will be particularly effective. Within the context of PSYOP design, officials would be presented with the same challenge. Moreover, there are numerous confounding factors neuromarketers face which make it difficult to elucidate the driving force of a choice or preference towards a product with fMRI. Expectation of quality (e.g. cheap vs. expensive wine) or branding, for instance, both have demonstrable effects on fMRI outcomes, making it difficult to manipulate a single factor to optimise an advertisement (McClure et al 2004; Plassmann et al 2008).

Even if one generously assumes fMRIs can provide otherwise unobtainable information, basic methodological limitations prevent fMRI, and subsequently NEURINT, from being a meaningful tool worth military investment. To conduct these NEURINT operations as described by Wurzmen and Giordano, a state must have access to a representative sample of volunteers from their target population. This is not a foregone conclusion in a conflict. The populations that NEURINT is most useful for, such as combatant terrorists or impenetrable enemies, would also likely prove to be the most difficult to statistically sample with fMRI studies. Furthermore, participants must remain completely still while in the MRI, necessitating cooperative subjects. Any restraints or anaesthetics used to immobilise an unwilling individual will likely interfere with the validity of the resulting information. Additionally, the success of many PSYOPs are predicated on a degree of covertness (Goldstein and Findley 1996). Implementing the necessary operational security to gather NEURINT from a representative and statistically valid population will prove to be a significant challenge. While there may be a technical capability, the use of fMRI to enable PSYOPS and NUERINT has practical challenges which preclude its use.

Biochemical weapons of willpower

Ultimately, the goal of a psychological operation is to degrade the will or ability of an opposing force to fight or erode the morale of a civilian population. A more direct approach towards this end is widespread deployment of NBCWs, which utilise psychiatric drugs or pathogens targeting the central nervous system to alter emotion, cognition and perceptions of armies, or an adversary’s domestic population. Rather than trying to subtly influence or coerce a people through labour-intensive PSYOPs, states may seek to change the hearts and minds of a civil population, or rapidly degrade or incapacitate a militant one with a NBCW.

As discussed earlier, psychiatric drugs can attenuate the neural signalling underpinning emotion, cognition and behaviour. When used individually, they lend themselves towards producing emotions which may be helpful in an interrogation. The widespread use of the same pharmaceuticals on the battlefield, however, has also increasingly become seen as a threat to conventional forces. For example, a 2008 DIA-sponsored report describes fears of a small group using NBCWs to swiftly incapacitate or degrade the ability of a larger US force to fight without engaging in combat (National Research Council 2008: 108). Additionally, at the 2016 meeting of the States Parties to the Chemical Weapons Convention (CWC), numerous states raised concerns that incapacitating agents which act on the central nervous system present significant challenges to the prohibition of chemical weapons. Under the CWC, chemicals which are used by law enforcement for riot control are not prohibited. This loophole could enable a state to legally develop advanced NBCWs under the guise of a riot control agent, and deploy them in a conflict.[3]

The most threatening, and most likely to be used, NBCWs are hypnotic drugs which reduce alertness, sedate, and anaesthetise (Royal Society 2012:44). Psychedelic drugs, however, which alter cognition, emotion, and behaviour also have potential for battlefield deployment because of their ability to disorientate. Moreover, the pharmaceuticals previously discussed for use as an interrogation aid can also be mass produced and weaponised to incite debilitating fear and anxiety on the battlefield. Numerous microbes and toxins which target the nervous system also have potential to affect the decision-making process to fight or surrender.[4] For example, the parasite *Toxoplasma gondii* can cause impulsivity, agitation and confusion, and the *Gambierdiscus toxicus* bacterium can cause nightmares and a burning sensation (Wurzman and Giordano 2014: 104).

Weapons which target the nervous system are not new. Nerve agents (e.g. sarin, sabin, VX) work by manipulating acetylcholine transmission in key motor areas, subsequently causing muscle spasms, paralysis, and death. What distinguishes the types of NBCWs of interest here – drugs and bugs that influence behaviour – from other biological and chemical weapons is they offer the ability to non-lethally incapacitate, rather than kill. History is rife with examples of attempted production of behaviour-influencing drugs. US-sponsored LSD experimentation originally started as an Army project focused on developing a chemical weapon that could rapidly degrade the fighting ability of a force (Marks 1979: 39-54). Moreover, a declassified US Air Force document reports that the US sought to develop a "gay bomb" which would have weaponised an aphrodisiac and was aimed at making enemy soldiers sexually irresistible to one another and deliver "a sharp blow" to combatant morale (Wright Laboratory). While the gay bomb never came to fruition due to a perceived lack of feasibility, there are currently several groups of behaviour-influencing drugs that can feasibly be scaled up and deployed in combat.

Both pharmaceuticals and microbes can undermine morale and cause troops to break ranks or flee in combat. Similarly, drugs and bugs can be used to increase aggression, alertness or reactiveness in a state's own forces (Royal Society 2012). These NBCWs have the ability to alter the perception of combatant troops, or, if spread over a population centre, to cause a swift change in the political support for a leader or to result in civil unrest (Royal Society 2012: 50). However, the same challenges that biological and chemical weapons have always faced – effective delivery and dissemination of the agent – are still relevant to neurologically-targeted NBCWs.

New science, old problems

In the fall of 2002, Russian Special Forces pumped a mixture of the opiates carfentanil and remifentanil into a theatre besieged by Chechen rebels in Moscow. The tactical use of these opioids was intended to sedate and enable the arrest of the captors without the loss of life (Walsh 2002). However, the opioid mixture was not disseminated in a uniform manner, resulting in varying concentrations and dosages throughout the theatre and the death of not only all of the Chechen rebels, but also 129 of the hostages (Tracey and Flower 2014). This oft-cited operation underscores another technical challenge of deploying NBCWs on the battlefield: widespread and uniform dissemination. If a drug was relied on to incapacitate a large ground force, obtaining an even distribution and dosage affecting all equally to maintain the non-lethality associated with a NBCW will pose to be a significant challenge.

While a NBCW may be disseminated through cutaneous absorption, aerosolisation and inhalation are the preferred methods to disseminate a NBCW due to the need for an agent to first enter the blood stream in order to cross the blood brain barrier (Royal Society 2012:50).[5] Aerosolisation has proven to pose a significant barrier to non-state actors seeking to use biological or chemical weapons. Aerosol droplets must be within a certain size to be able to penetrate respiratory tissue and enter the blood stream. If the droplet is too small, particles will simply be exhaled. If it is too large, the droplet will be trapped in the passages of the respiratory tract. A munition can deliver and correctly aerosolise a biological or chemical weapon, but degrades large proportions of the agent on impact, and thereby limits its utility (Kerr 2008). But if the advantage of a NBCW over the more traditional biological and chemical weapons is their ability to non-lethally alter mood and perceptions, the high mortality rate resulting from the explosion of the munition itself would inhibit desired non-lethal outcomes as well.

Industrial sprayers can also aerosolise and deliver a NBCW, but getting the sprayer in proximity to a target population can be challenging – especially for a non-state group. Yet, access to a sprayer does not necessarily indicate capability to disseminate a NBCW. The difficulty of obtaining a droplet in the ‘sweet spot’ has prevented many would-be bioterrorists from completing successful attacks and will continue to do so. For example, a 1993 attempt by the Japanese Aum Shinrikyo cult to use anthrax in a terrorist attack failed because their dissemination method produced droplets that were too big to be carried by the wind, let alone be absorbed into the body (Takahashi et al). While this is less of a challenge for states with access to sophisticated technology or agents available as a gas, as the Moscow theatre incident demonstrates, it is difficult – if not impossible – to disseminate a NBCW in a manner which accounts for variations in the dosage needed to incapacitate – but not kill –large groups.

It is hard to imagine a scenario where an actor could deploy these types of weapons broadly and ensure that all the intended targets receive a dose which is sufficient to influence behaviour, but not kill. What is a proper dose for one, can prove deadly to another. Similarly, considering the varying immunological profiles of individuals, a behaviour altering microbe could work perfectly in some, but be ineffectual in others (Tracey and Flower 2014). If even dissemination and distribution cannot be accomplished, then these weapons are no different from traditional biological and chemical weapons.

At the surface fMRIs and NBCWs seem to present the ability to use behavioural neuroscience to control and manipulate societies and armies. However, after further inspection there are several technical and practical barriers limiting their use. fMRI may be theoretically useful in PSYOP design, but the added complexity introduced by its use coupled with the marginal – if any – benefits it can provide to security services makes it unlikely to be used. Similarly, while many NBCW agents that can influence behaviour are available, their weaponisation in a manner which retains their non-lethal characteristics significantly limit their use.

Conclusion

Scientific breakthroughs in the biological basis of behaviour and cognition have given rise to numerous treatments for neurological and psychiatric disorders that have improved the quality of life for many people all over the world. While current developments within neuroscience have sparked renewed interest in their potential for weaponization and other military and intelligence uses, the hype around these developments far exceeds current capacities. Make no mistake, psychiatric drugs, brain stimulation, brain imaging and NCBWs can be misused to alter emotions or memories, incept ideas, cause cognitive shifts, and affect behaviour. However, there are still significant technical challenges to doing so and operationalising neuroweapons remains extremely difficult.

Yet, while it is unlikely that promises of mind control will be realised by neuroweapons any time soon, it would be naïve to assume that approaches to behavioural control will not become more refined over time, and that barriers to misuse will not lower as we continue to pursue better psychiatric treatment. This point is underscored by the rapid pace of scientific advancement in other fields that have more broadly contributed to a changing threat perception emanating from the life sciences. In the past five years, gene editing and synthetic biology have made significant strides and have raised new fears that highly lethal biological agents can be produced in the lab from scratch (DiEuliis et. al 2017; Koblentz 2017), or produce genetically modified pathogens which are more lethal, contagious, or resistant to existing medical countermeasures (Clapper, 2016). Moreover, DiEuliis and Giordano (2017) have noted that CRISPR/CAS-9 gene editing may be used as a path to novel neuroweapons that are far superior to current weaponisable pathogens acting on the central nervous system. As neuroscience progresses, the technologies discussed here can be weaponised and deployed by actors willing to expend the time, money and resources necessary to further develop them.

International humanitarian law[6] and armament law[7] form crucially important components in governing the development and use of neuroweapons. On the surface, these standards prohibit neuroweapons. Their strength, however, has been weakened by ambiguities and the defiance of state actors. For instance, the lack of guidance on specific actions which constitute torture by international bodies enabled the Bush administration to argue the EITs of the CIA did not meet the severity threshold of pain or mental injury required by international law and, thus, could not be considered torture under existing treaties (Mayerfeld 2007). In the context of state-attempts at behavioural control, the same argument can be used to explain away the use of pharmaceuticals or neurotechnology which malevolently alters the inner workings of the brain. The prohibition of NBCWs by armament law is much stronger, but here too there are loopholes and ambiguities. The exclusion of chemical weapons intended for riot control under the Chemical Weapons Convention, for instance, provides space for states to legally develop incapacitating weapons under the guise of a domestic riot control agent, and then rapidly convert NBCWs for use in conflict (Royal Society 2012: 21-24).

Further challenging the governance framework, are suggestions that, as the technologies described here become more developed, there may be shifts in perceived utility – as we are witnessing more generally with respect to biological weapons (Lentzos 2017). For example, Keane (2010) suggests drugs that simulate a state of euphoria and positive emotions to make a person talk are not only permissible, but a morally superior substitute for torture and enhanced interrogation. Existing socio-political calculations about the utility of neuroscience-based influence weapons may change and drive further military and intelligence development. These shifting perceptions are coupled with increasing geopolitical turbulence and a shift away from state-centric conflict wherein behavioural control may become ever more tempting (Dando 2015:174-75).

If this prediction holds to be true, the changing perception of neuroscience-based influence weapons will place significant strain on humanitarian and armament law. In recent history, there have been several challenges to the taboos against inhumane treatment and to biochemical weapons, and these challenges are likely to continue. The continual use of chemical weapons in Syria, for instance, to indiscriminately target civilians with chlorine and sarin gas attacks – and the inability of the United Nations to prevent and punish their use – greatly endangers the international taboo associated with unconventional weapons, and risks broader legitimisation of chemical weapon attacks (Ilchmann and Revill 2014). Moreover, the Bush administration's refusal to adhere to international principles on the use of EITs has resulted in a general degradation of norms against torture (McKeown 2009). Despite the prohibition by humanitarian law and the recommendations of senior interrogators, top decision leaders remain convinced that torture is efficacious and refuse to uphold human rights. President Trump appears to be an active proponent of coercive techniques. Both while campaigning and after sworn into office, President Trump described a belief in the efficacy of torture and even went as far as saying he would "bring back a hell of a lot worse than waterboarding," (McCarthy 2016; Gordon 2017) and has advocated for excessive police brutality (Wootson and Berman 2017). Moreover, there have been reports of torture and human rights violations emanating from Crimea following its Russian annexation (Cumming-Bruce 2017) and Chinese prisoners continue to be subjected to aggressive interrogation methods designed to degrade prisoners' will power and incite cooperation (Washington Post Editorial Board 2017).

As the world order continues to move away from one clear dominant power – America – to an increasingly multipolar world, where rising powers view human rights, justice, transparency and use of force differently, the challenges to humanitarian and armament law will only increase. To monitor the conversion of behavioural neuroscience from benign medical treatments to malignant weapons, and to shape how neuroweapons may be perceived and used, it is of the utmost importance that the international community strengthens the existing normative and legal framework embodied in multilateral treaties and national laws and regulations. The medical standards, codes of practice and research ethics that doctors and scientists are obliged to uphold must also be strengthened with a view to the potential misuse of behavioural neuroscience. The containment of neuroweapons relies on the strength of norms from the top down and the bottom up against the use of torture, unconventional weapons and the militant use of neuroscience.

The analysis presented here is largely predicated on a state's desire for sophisticated weaponry and for predictability and assurances of efficacy, as well as its compulsion to comply with international norms and treaties. If these requirements are taken out of the equation, the barriers to entry of neuroweapons quickly decrease. For example, terrorist groups may seek psychiatric drugs as a direct route to torture, or, akin to previous Soviet interrogation attempts, simply to make a person publicly 'confess' to any sort of crimes. Furthermore, administration of psychiatric drugs requires expert knowledge, but due to the widespread use and availability of street drugs, their effects are well known and can be used without a basic understanding of the neuroscientific principles underpinning them. It would be relatively easy for an unsophisticated non-state group to obtain LSD or other mind-bending drugs and covertly administer them to prisoners without facing the need for predictability and reliability that a state seeking to use drugs to illicit accurate information may face. The Islamic State (ISIS) has already used pharmaceuticals to dose their fighters with Captagen, an amphetamine which – based on reports of returning fighters – makes ISIS combatants resistant to pain and more courageous (Gidda 2017). Additionally, a state can just as easily turn these technologies inward and use them against their domestic population. While the technologies described here can and have been used as riot control agents or in narcoanalysis, brain imaging also has interesting implications for use in crafting political messages focused at a sub-section of voters.

That caveat aside, in sum: Is using neuroscience to influence, coerce, and manipulate a threat? Yes, it is. While still difficult, there is an emerging technical capability for behavioural neuroscience to be used to enable a new class of influence weapons. Yet, it is not a near-term threat and it is heavily dependent upon technological development which makes neuroscience cheaper and easier to use in a combat setting—as well as on more organisational, managerial, social political and economic factors (Ben Ouagrham-Gormley 2014). It is also dependent on the willingness of an actor to defy international law and ethical standards. Both scientists and the international community must remain vigilant about behavioural neuroscience leaking into the security realm.

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[1] MKULTRA is also known in the literature by previous code names 'BLUEBIRD' and 'ARTICHOKE'

[2] In addition to enabling the design of refined PSYOPs, these authors posit that the cultural information obtained by fMRI can provide richer context in the collection and analysis of HUMINT and SIGINT.

[3] At the time of writing, closing this loophole continues to be an explicit goal for certain CWC states parties. An agreement banning agents acting on the central nervous system is currently being advocated for by nearly 40 states (as of November 2017), and if consensus is reached, could close off this potential avenue for the proliferation of NBCWs.

[4] There are many neuro-microbial agents outside the scope of this article on behavioral influence that also target the central nervous system. For a comprehensive review, see Giordano 2014: 103-7.

[5] Small neuromodulators, notably Oxytocin and Testosterone, can reach the brain through nasopharyngeal passages, but the vast majority of potential NBCW agents do not have this capability and must be inhaled and transferred to blood through respiratory tissue. See Crockett and Fehr (2014).

[6] Most relevantly: the 1948 Universal Declaration of Human Rights, the 1966 International Covenant on Civil and Political Rights, and the 1987 Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment.

[7] Most relevantly: the 1925 Geneva Protocol, the 1972 Biological Weapons Convention, and the 1993 Chemical Weapons Convention.

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